

CHAPTER 8 - PARTS MOUNTING

8.1 General

Parts, terminals, and conductors shall be mounted and supported as prescribed herein. Dimensions provided in this chapter are for acceptance and/or rejection criteria only. Unusual environmental applications require special design measures to provide necessary environmental survival capability. Such measures shall be detailed on the appropriate engineering documentation. Engineering documentation shall prescribe which alternative approach is selected, as well as staking compounds and conformal coating requirements. They shall also detail any special mounting arrangements or design requirements not fully covered herein.

1. **Stress Relief.** Stress relief shall be incorporated, wherever possible, into all leads and conductors terminating in solder connections to provide freedom of movement of part leads or conductors between points of constraint. Leads shall not be temporarily constrained against spring-back force during solder solidification so that the joint is subject to residual stress. Examples of stress relief are shown in figures throughout this chapter.

2. **Part Positioning.** Parts shall be positioned in compliance with the engineering documentation and mounted in accordance with the requirements specified herein.

a. Parts shall be mounted so that terminations of other parts are not obscured. When this is not possible, interim assembly inspection shall occur to verify that the obscured solder joints meet the requirements herein.

b. Parts having conductive cases mounted over printed conductors or which are in close proximity with other conductive materials shall be separated by insulation of suitable thickness. Insulation shall be accomplished so that part identification markings remain visible and legible.

3. **Visibility of Markings.** Where possible, parts shall be mounted in such a manner that markings pertaining to value, part type, etc., are visible. For parts marked in such a way that some of the marking will be hidden regardless of the orientation of the part, the following shall be the order of precedence for which markings shall be visible:

- a. Polarity.
- b. Traceability code (if applicable).
- c. Piece part value and type.

4. **Glass Encased Parts.** Glass encased parts such as diodes, thermistors, or resistors shall be covered with transparent resilient sleeving or other approved material when epoxy material is used for staking, conformal coating, or encapsulating or where damage from other sources is likely. The epoxy material shall not be applied directly to glass.

CAUTION: WHEN USING HEAT SHRINKABLE SLEEVING, EXTREME CARE SHOULD BE TAKEN TO PREVENT PART DAMAGE DUE TO EXCESSIVE HEAT OR SHRINKAGE OF THE SLEEVING.

5. **Hookup Wire.** Hookup wire, solid or stranded, shall be supported by a means other than the solder connections or conformal coating if wire length exceeds 2.54cm (1 inch). Attachment to a surface by staking with resin is considered adequate support.

6. **Lead Bending and Cutting.**

a. During bending or cutting, part leads shall be supported on the body side to minimize axial stress and avoid damage to seals or internal bonds. The distance from the bend to the end seal shall be approximately equal at each end of the part. The minimum distance from the part body or seal to the start of the bend in a part lead shall be 2 lead diameters for round leads and 0.5mm (0.020 inch) for ribbon leads. The stress relief bend radius shall not be less than the lead diameter or ribbon thickness. The direction of the bend should not cause the identification markings on the mounted part to be obscured. Where the lead is welded (as on a tantalum capacitor) the minimum distance is measured from the weld.

b. Part leads shall be formed so that they may be installed into the holes in the PWB without excessive deformation that can stress the part body or end seals.

c. All leads should be tinned and formed before mounting the part.

CAUTION: WHERE POSSIBLE, PART LEADS THAT ARE SUBJECT TO STRESS CORROSION CRACKING (E.G. KOVAR LEADS), SHALL BE PREFORMED AND TRIMMED PRIOR TO TINNING.

d. Whether formed manually or by machine, part leads shall not be mounted if they show evidence of nicks or deformations. Smooth impression marks (base metal not exposed) resulting from tool holding forces shall not be cause for rejection.

e. Tempered leads (sometimes referred to as pins) shall not be bent nor formed for mounting purposes since body seals and connections internal to the part may be damaged. Tempered leads or leads with a diameter of 1.27mm (0.05 inch) or more shall not be cut with diagonal cutters or other tools that impart shock to connections internal to the part.

7. **Coated Parts.** Parts shall be mounted so that the insulating coating meniscus applied by the manufacturer on the leads does not enter the mounting hole or soldered connection.

8. **Splices.** Broken or damaged conductors, part leads, or printed wiring conductors shall not be spliced.

9. **Location.** Part bodies shall not be in contact with soldered terminations.

8.2 Mounting of Terminals

1. **General.** Use of terminals shall generally be restricted to situations where parts are expected to be removed and replaced, or where there are other compelling design requirements for their use.

a. Terminals shall not be used as the interface connections in non-plated through holes (PTH's). Swaging of terminals shall be performed in a way that does not damage the PWB.

b. After swaging or flaring, the rolled area or flange shall be free of circumferential splits or cracks, but may have a maximum of three radial splits or cracks provided that the splits or cracks are separated by at least 90° and do not extend beyond the coiled or flared area of the terminal (Figure 8-1).

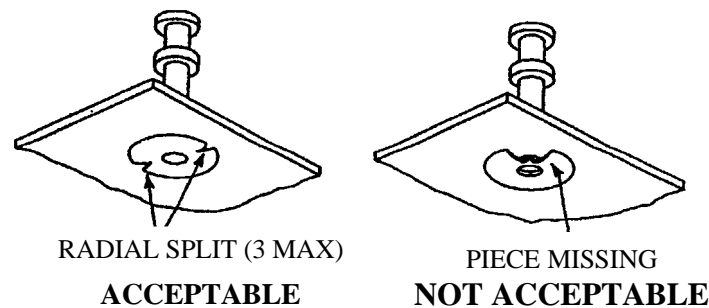


Figure 8-1. Terminal Damage

2. Swage type terminals in non-PTH's, designed to have the terminal shoulder soldered to the printed wiring conductor, shall be secured to the PWB by a roll swage (Figure 8-2).

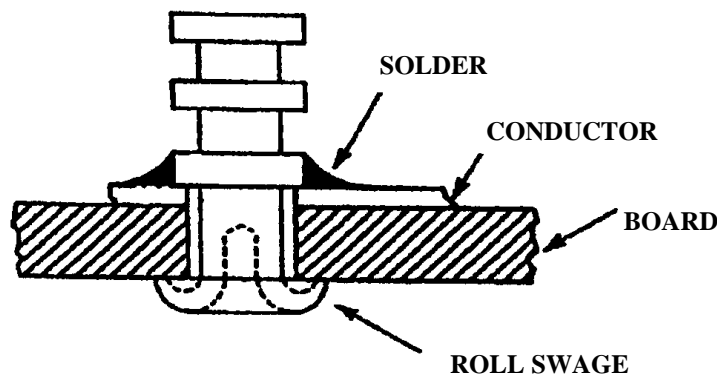


Figure 8-2. Roll Flange Terminal

3. PWB designs calling for soldering of the swaged end of the terminal to the printed wiring conductor on a single-sided PWB shall have the terminal secured with a V-funnel swage (refer to Figure 8-3).

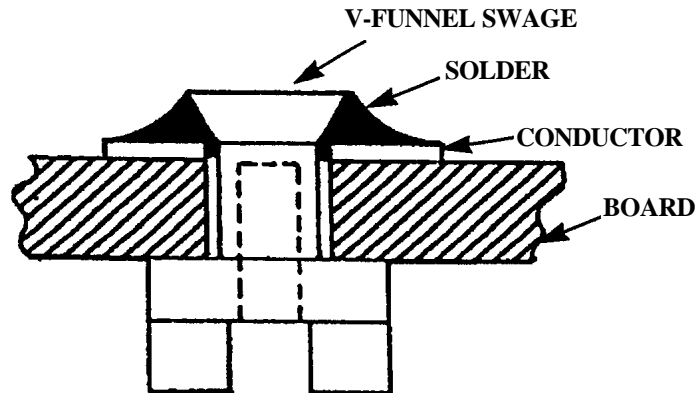


Figure 8-3. V-Funnel Type Swage

4. Swage type terminals that are mounted in a PTH shall be secured to the PWB by a V-funnel swage (Figure 8-3) or an elliptical funnel (Figure 8-4) swage. The elliptical funnel swage is the preferred method for attachment. Terminals shall be swaged such that they can be rotated under finger force.

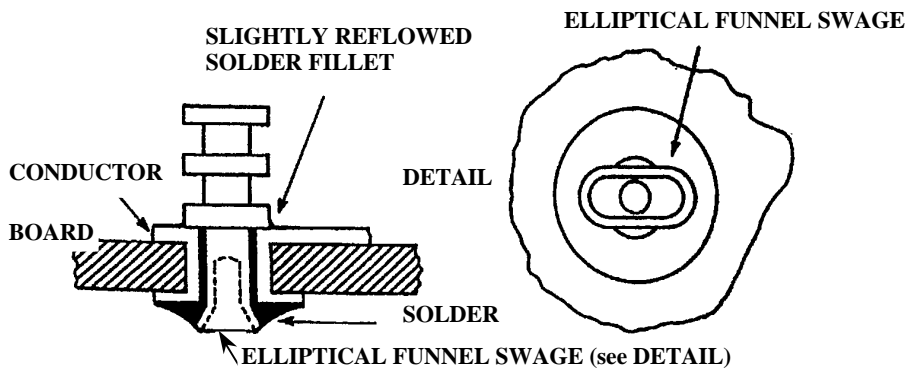


Figure 8-4. Elliptical Funnel Type Swage

8.3 Mounting of Parts to Terminals

1. **Parallel Mounting.** Parts shall be mounted parallel to, and in contact with, their mounting surface. Slight angularity is permissible.
2. **Lead Lengths.** The length of leads between parts and terminals should be approximately equal at both ends, except when special part shapes require staggering.
3. **Stress Relief.** Where parts are mounted between bifurcated terminals, without lead wrap, it is not mandatory that the part leads have stress relief bends. Where parts are mounted between other terminal types, it is mandatory to put a stress relief bend in at least one lead (Figure 8-5).

SR = STRESS RELIEF BEND
CP = CONSTRAINT POINT

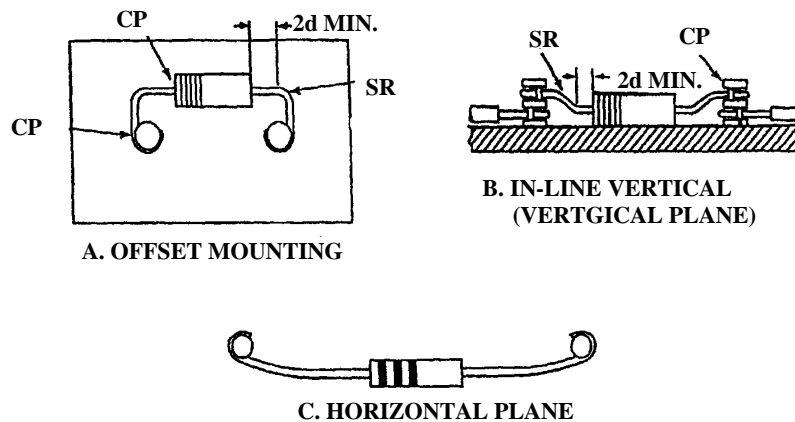


Figure 8-5. Stress Relief Examples

CAUTION: CARE SHALL BE EXERCISED TO ASSURE THAT SWAGED SOLDER CONNECTIONS ARE NOT MECHANICALLY STRESSED DURING PART MOUNTING OPERATIONS.

4. **Wrapping and Routing.** Degrees of wrap and routing are specified in Chapter 9.

8.4 Mounting of Parts to PWB'S

1. **Parts Mounted To PWB's.** Solder terminations shall be visible for inspection after soldering. In the cases where visual inspection cannot be accomplished, a nondestructive method of inspection shall be performed (e.g., X-ray or fiberscope). The nondestructive method of inspection to be used shall be documented and approved by the procuring NASA Center prior to use. Recommended terminations and mounting techniques are shown throughout this chapter.

2. **Axial Lead Mounting.** Axial leaded parts shall be mounted as follows:

- a. **Horizontal Mount.** Parts intended for horizontal mounting shall be parallel to, and in contact with, the mounting surface (see Figure 8-6), or as specified in the engineering documentation. Slight angularity is permissible. When parts will be bonded, slight spacing will be acceptable.

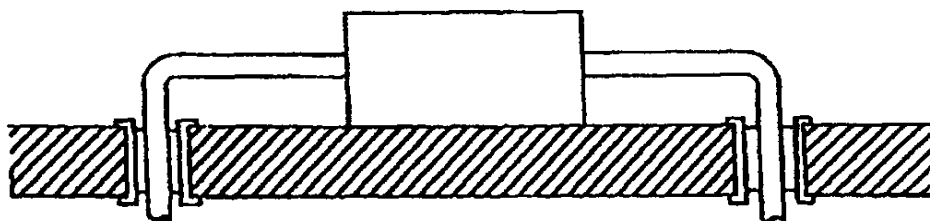


Figure 8-6. Horizontal Mount

b. Vertical Mount.

(1) **Plated-Through Hole.** The end of the part body must be mounted with at least 0.5mm (0.020 inch) to a maximum of 1.27mm (0.050 inches) clearance above the PWB surface or as specified on engineering documentation. The end of the part is defined to include any extensions such as coating meniscus, solder seal, or weld bead (see Figure 8-7A).

(2) **Non-Plated-Through Hole.** The end of the part body may be mounted flush with the PWB surface and shall be terminated with an off-the-pad-lap solder joint. The part shall be staked on the part side of the PWB. The opposite lead shall have two approximate right angle bends (see Figure 8-7B).

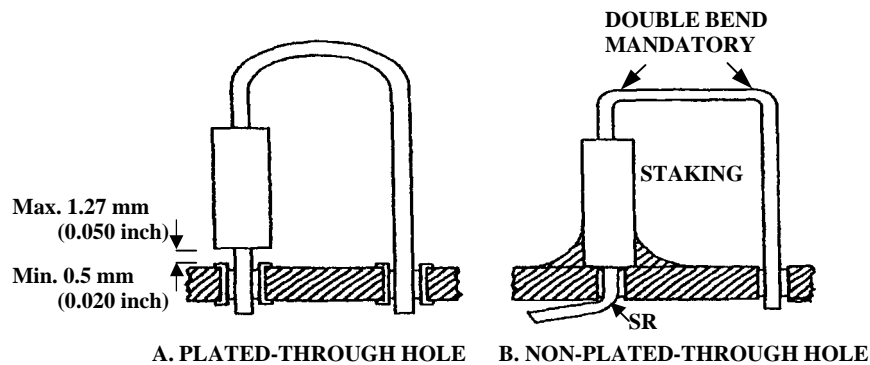


Figure 8-7. Vertical Mount

3. **Radial Lead Mounting.** Plated-through-hole: The part body shall be mounted with at least 0.5mm (0.020 inch) to a maximum of 1.27mm (0.050 inch) and shall allow inspection of the solder joint. The part body includes any extension such as coating meniscus, solder seal or weld bead (see Figure 8-8A).

Non-plated-through-hole: The part body may be mounted flush with the PWB surface and terminated with an off-the-pad lap solder joint (See Figure 8-8B).

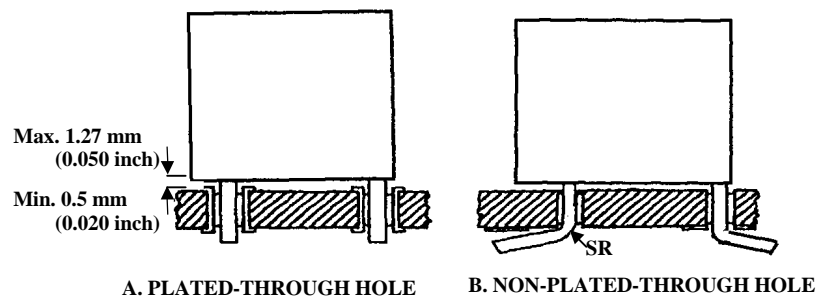


Figure 8-8. Radial Leaded Parts

4. **Hole Obstruction.** Parts shall not be mounted such that they obstruct solder flow or prevent cleaning of the topside termination areas of PTH's (Figure 8-9).

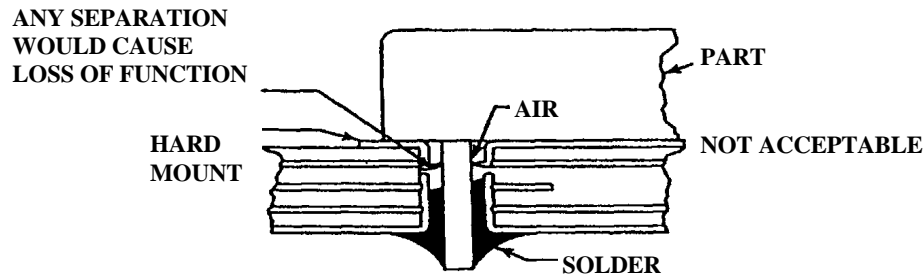


Figure 8-9. Hole Obstruction

5. **Parts with Leads Terminating on Opposite Sides.** Stress relief shall be provided in the part lead between the part body and solder terminations (Figure 8-10). The lead may be terminated by clinch, straight-through, or lap configuration.

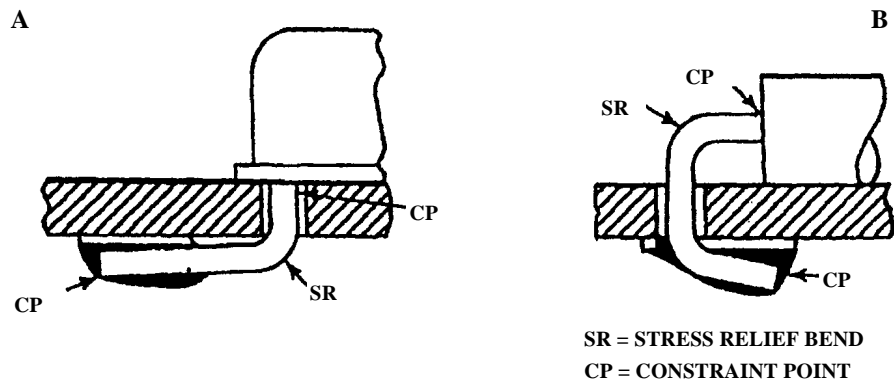


Figure 8-10. Stress Relief Part Termination

6. **Parts with Leads Terminating on the Same Side.** Stress relief shall be provided by forming the part leads at a bend angle to the PWB of not more than 95° nor less than 45° (Figure 8-11).



Figure 8-11. Bend Angle

7. **Conductors Terminating on Both Sides.** Stress relief shall always be provided in the part lead between the part body and solder termination. When a conductor is used to interconnect opposite sides of a PWB, stress relief or a PTH shall be provided (Figure 8-12).

CP = CONSTRAINT POINT
SR = STRESS RELIEF

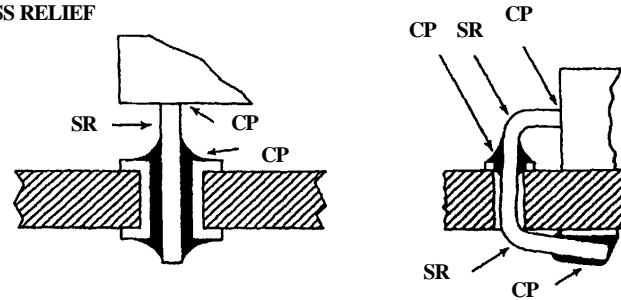


Figure 8-12. Conductors Terminating on Both Sides

8.5 Boards Lead Terminations, Printed Wiring

Part Lead Terminations. Part leads shall be of the lap, clinched, or straight-through configuration as defined by the engineering documentation and shall be terminated in accordance with paragraphs 8.4-1 through 8.4-3. No more than one item, whether conductor or part lead, shall be inserted in any one hole.

1. Lapped Terminations. Lapped terminations consist of both round and flat ribbon leads. It is preferred that leads be seated in contact with the termination area for the full length of the foot. Separation between the foot of the lead and the surface of the termination area shall not exceed 0.25mm (0.010 inches) (see Figure 8-13).

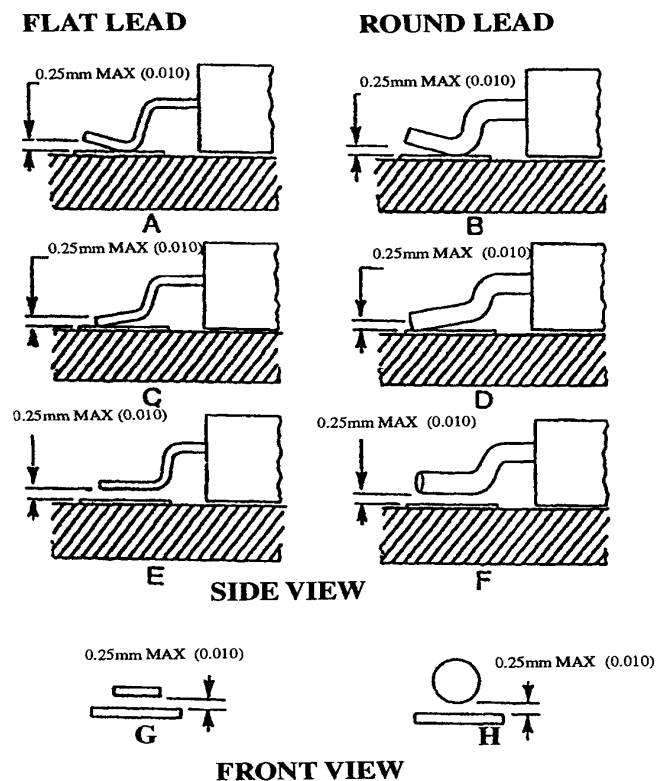
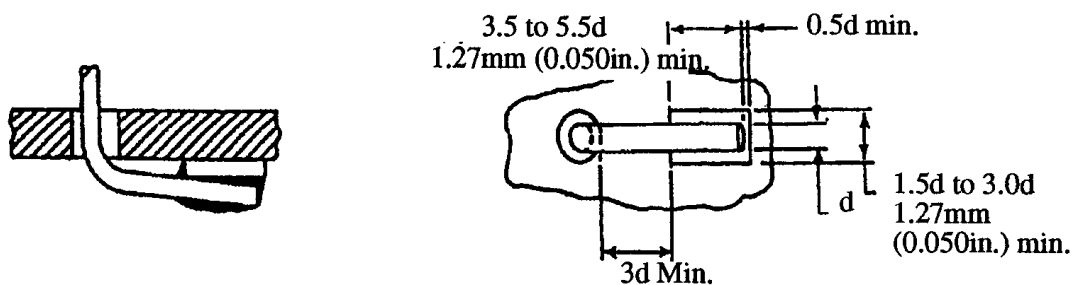
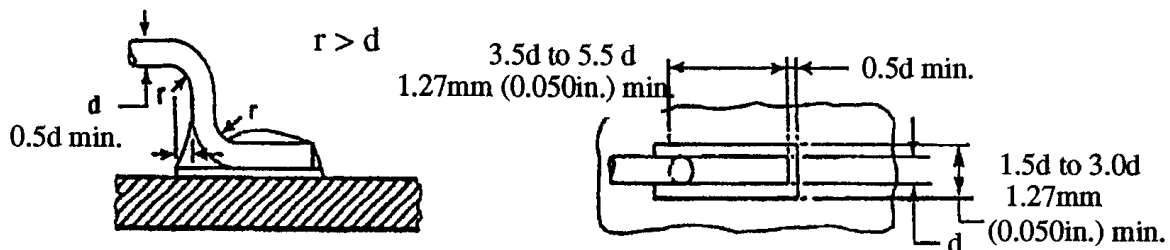


Figure 8-13. Lapped Lead Height above Board

a. Lapped Round Leads. The round lead shall overlap the solder pad a minimum of 3.5 times the lead diameter to a maximum of 5.5 times the lead diameter, but in no case shall the length be less than 1.27mm (0.050 inch). The cut-off end of the lead shall be no closer than $\frac{1}{2}$ the lead diameter to the edge of the solder pad. Only that portion of the lead extending to the part body or to another soldered connection shall be beyond the solder pad (Figure 8-14A). For lapped terminations where the part body is on the same side of the PWB as the termination area, a heel fillet is mandatory (Figure 8-14B).



A. SINGLE SURFACE LAPPED TERMINATION



B. SINGLE SURFACE LAPPED TERMINATION

Figure 8-14. Lapped Round Termination

b. Lapped Ribbon Leads. The ribbon lead shall overlap the solder pad a minimum of 3 lead widths to a maximum of 5.5 lead widths. Only that portion of the lead extending to the part body or to another soldered connection shall be beyond the pad. The cut-off end of the lead shall be a minimum of 0.25mm (0.010 inch) from the end of the pad. One edge of the lead may be flush with the edge of the solder pad. There shall be sufficient area around two of the three lead edges to accommodate solder filleting (see Figure 8-15). In instances where ribbon leads are less than

0.5mm (0.020 inch) in width, ribbon overlap shall be no less than 1.27mm (0.050 inch). For lapped terminations where the part body is on the same side of the PWB as the termination area, a heel fillet is mandatory (Figure 8-15).

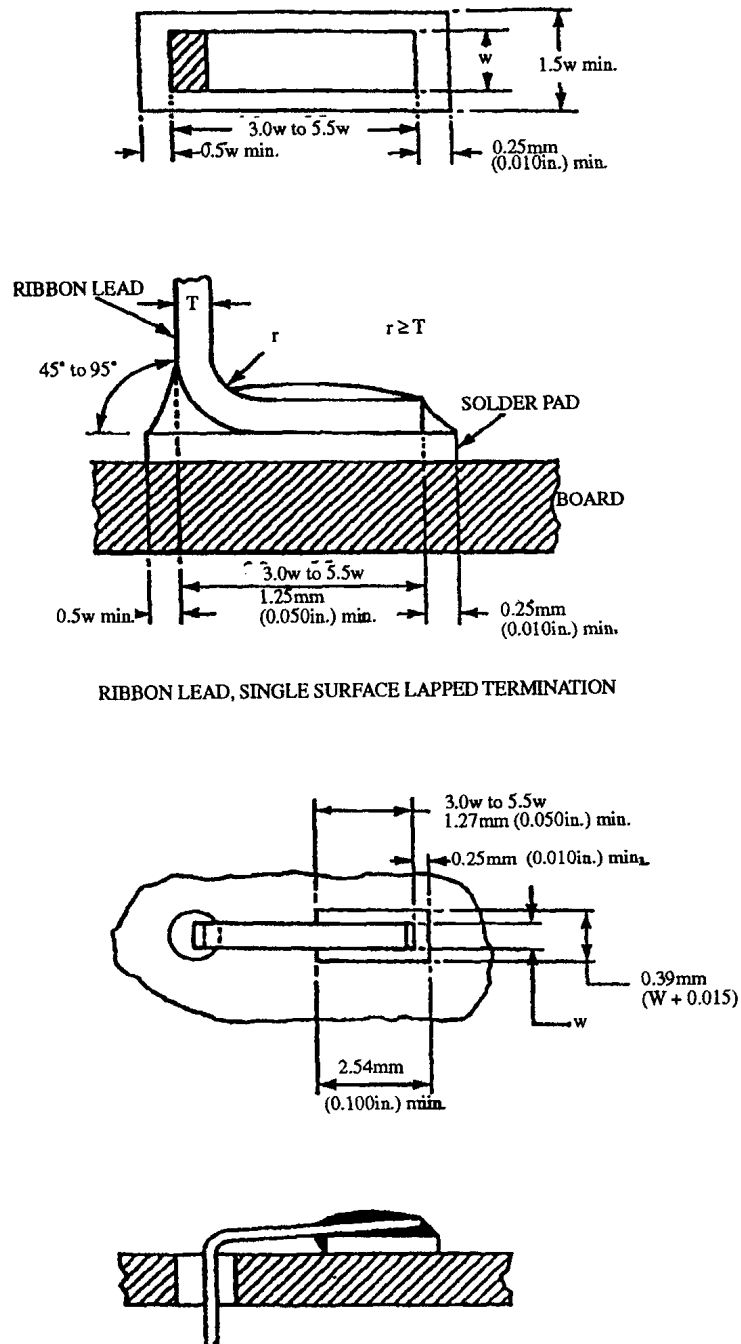


Figure 8-15. Lapped Ribbon Leads

2. Clinched Lead Terminations. The length of the clinched portion of conductors and part leads shall be at least $\frac{1}{2}$ the largest dimension of the solder pad or 0.78mm (0.031 inch), whichever is greater. Lead overhang shall not violate minimum electrical spacing requirements. The lead shall be bent in the direction of the longest dimension of the solder pad. If the pad dimensions are not sufficient, the lead shall be bent in the direction of the printed wire path (Figure 8-16). There shall be sufficient solder pad area extending beyond the sides of the lead to accommodate solder filleting. Fully clinched leads are defined as leads bent between 75° and 90° from a vertical line perpendicular to the PWB (Figure 8-17). Nonbendable leads shall not be clinched.

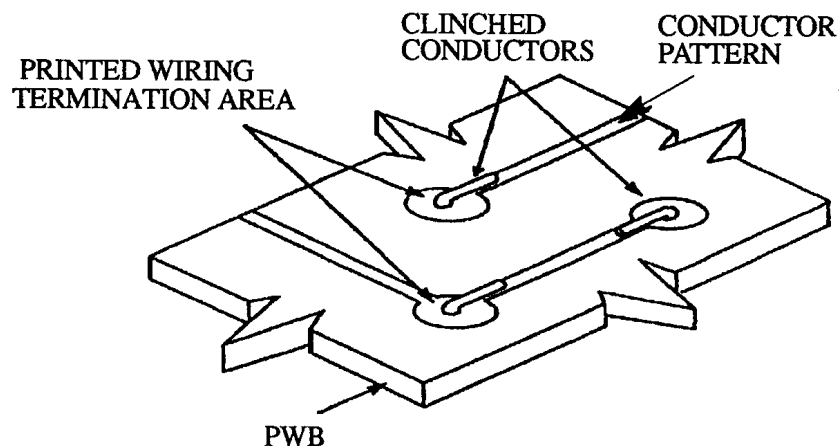


Figure 8-16. Clinched Termination

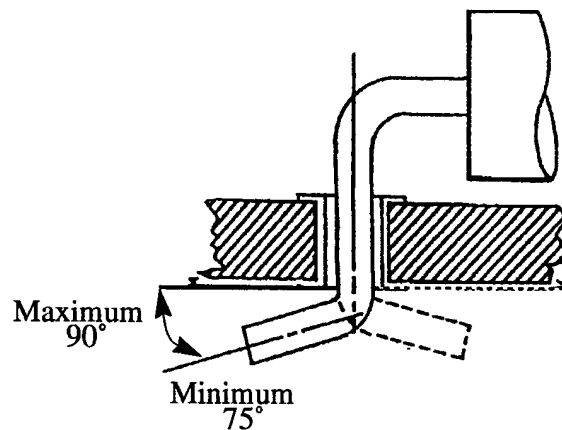


Figure 8-17. Lead Bend

3. Straight-Through Lead Terminations. Part leads terminated straight through the PWB shall extend a minimum of 0.5mm (0.020 inch) and a maximum of 2.29mm (0.090 inch) (Figure 8-18). The minimum lead length shall be determined prior to soldering (actual measurement is not required except for referee purposes). Straight-through leads may be bent up to 30° from a vertical plane to retain parts during the soldering operation (Figure 8-19). Nonbendable leads shall not be bent.

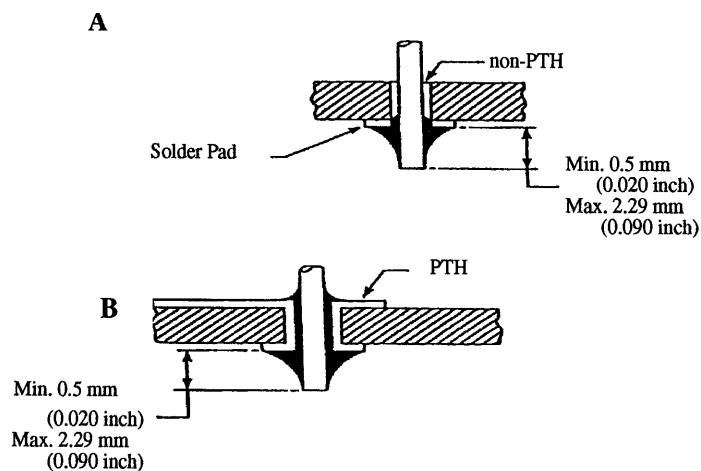


Figure 8-18. Straight-Through Termination

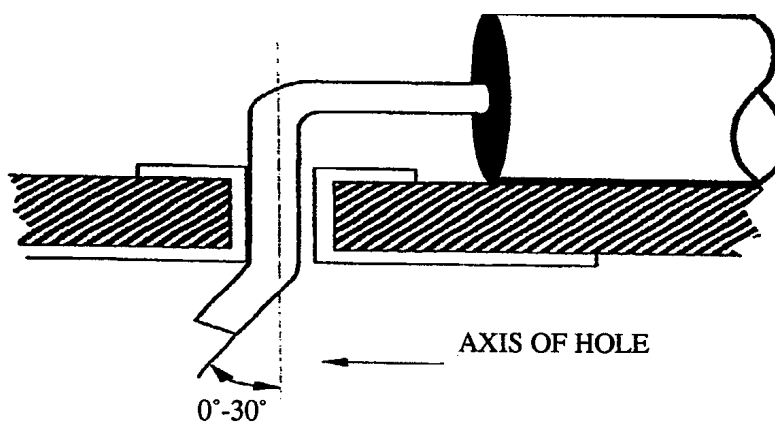


Figure 8-19. Straight-Through Lead Retention

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